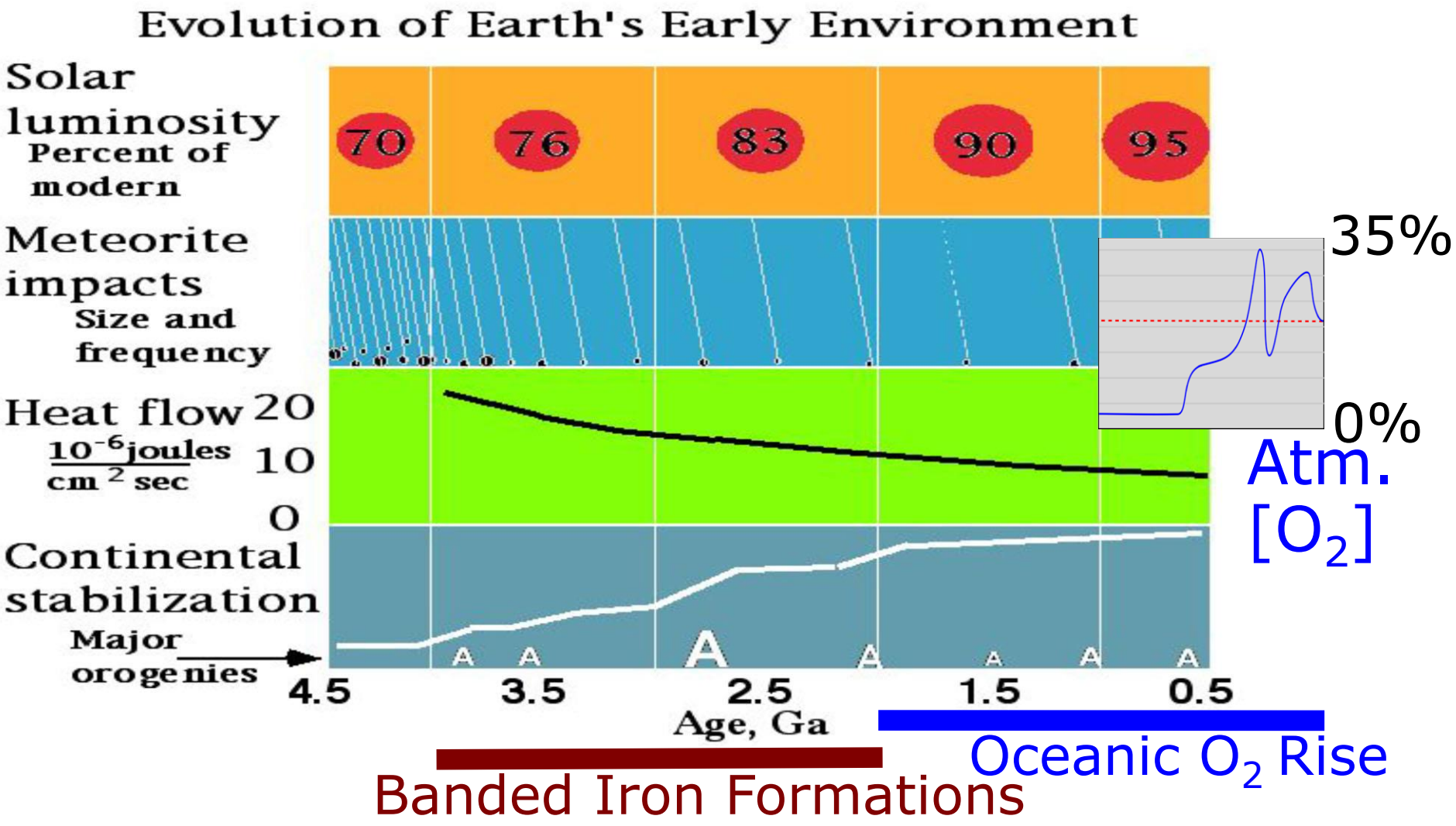
Current Planetary Protection Policy and Human Spaceflight

C. Conley, NASA PPO
(and many others)

What are the origins, distribution, and future of life in the universe?

Life Affects the Evolution of Planets



Organisms Thrive in Strange Places...

Some communities are made up of small numbers of species: frequently found in more ‘extreme’ environments

Most organisms live in fairly complex communities, in which members share resources and improve community survival

Lichens survive space exposure

And Eat All Kinds of Things...

Many organisms use unusual energy sources: sulfate, perchlorate, photons...

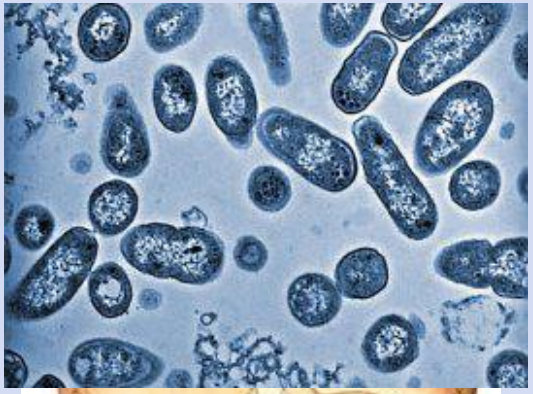
This community lives off radioactive decay of rocks around it: *no* input from the surface, or the sun

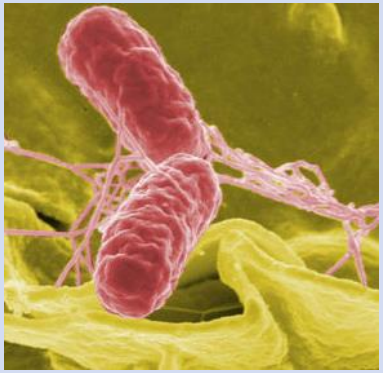
Cave microbes thrive off the chemistry of rocks, water, and volcanism, and support whole communities

Introduced Organisms Can Have Ecological Impacts

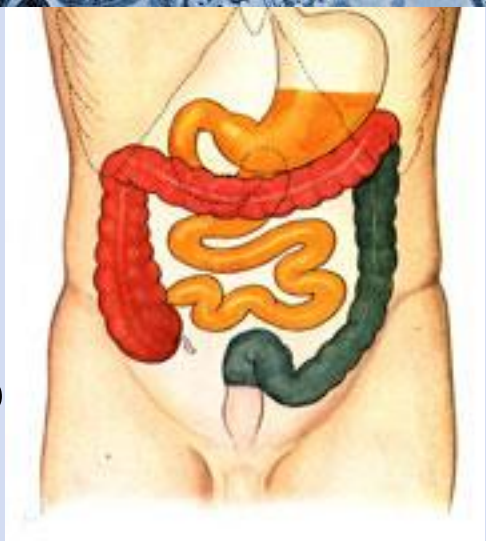
Stable communities are resistant to invasion by novel species

Salmonella typhimurium express more virulence genes after cultured in space

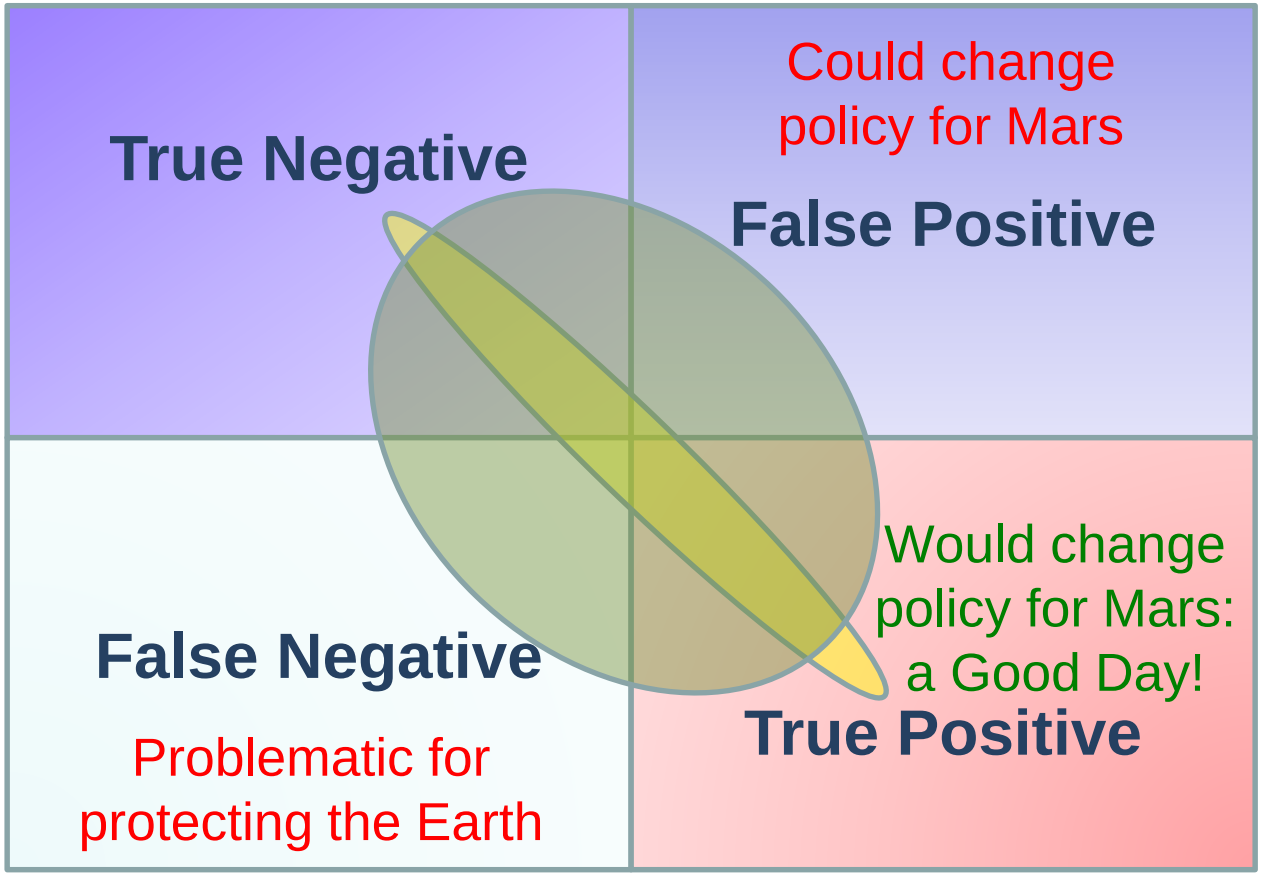




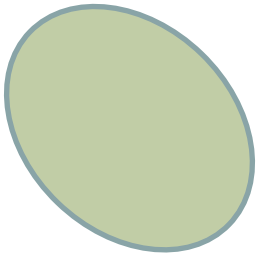
However, sometimes organisms with novel capabilities can sweep through a community



Organic Contamination and Life Detection



Narrow Ellipse = Minimal False positives and negatives



Broad Ellipse = Range of False positives and negatives

International Agreements on Planetary Contamination/Protection

- The Outer Space Treaty of 1967:
  - Proposed to the UN in 1966
  - Signed by the US and Soviet Union in January 1967
  - Ratified by the US Senate on Apr. 25th, 1967
- Article IX:

"...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose..."

"Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies."
(http://www.state.gov/t/ac/trt/5181.htm)

Committee on Space Research (COSPAR) and NASA Policy

- COSPAR maintains a planetary protection policy representing the international consensus standard for the 1967 UN Space Treaty.
- NASA Planetary Protection Policy *NPD 8020.7* is consistent with COSPAR:

  "The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from *another planet or other extraterrestrial sources* / an interplanetary mission. Therefore, for certain space-mission/target-planet combinations, controls on *organic and biological* contamination *carried by spacecraft* shall be imposed..."

NASA Planetary Protection Policy

- The policy and its implementation requirements are embodied in NPD 8020.7G *(approved by NASA Administrator)*
  - The Planetary Protection Officer acts on behalf of the Associate Administrator for Science to maintain and enforce the policy
  - NASA obtains recommendations on planetary protection issues (requirements for specific bodies and mission types) from the National Research Council's Space Studies Board
  - Advice on policy implementation is obtained from the NAC Planetary Protection Subcommittee
- Specific requirements for robotic missions are embodied in NPR 8020.12D *(approved by SMD Associate Administrator)*
  - Encompasses all documentation and implementation requirements for forward and back-contamination control
- General guidelines for human missions are outlined in a NASA Policy Instruction, NPI 8020.7 *(approved by AAs, SMD and HEO)*
- Consistent with COSPAR policy: NASA supports international missions only if COSPAR policy is followed

Planetary Protection Mission Constraints

- Depend on the nature of the mission and on the target planet
- Assignment of categories for each specific mission/body is to “take into account current scientific knowledge” via recommendations from advisory groups (SSB, PPS).
- Examples of specific measures include:
  - Constraints on spacecraft operating procedures
  - Spacecraft organic inventory and restrictions
  - Reduction of spacecraft biological contamination
  - Restrictions on the handling of returned samples
  - Documentation of spacecraft trajectories and spacecraft material archiving

W. Peet, 1967

Planetary Protection Mission Categories

PLANET PRIORITIES		MISSION TYPE	MISSION CATEGORY
A	Not of direct interest for understanding the process of chemical evolution. No protection of such planets is warranted.	Any	I
B	Of significant interest relative to the process of chemical evolution, but only a remote chance that contamination by spacecraft could jeopardize future exploration. Documentation is required.	Any	II
C	Of significant interest relative to the process of chemical evolution and/or the origin of life or for which scientific opinion provides a significant chance of contamination which could jeopardize future biological experiments. Substantial documentation and mitigation is required.	Flyby, Orbiter	III
		Lander, Probe	IV
All	Any Solar System Body	Earth-Return	V

"restricted" or "unrestricted"

Planetary Protection Considerations for Robotic and Human Missions

- Avoid contaminating target bodies that could host Earth life (e.g., Mars, Europa, Enceladus)
- Ensure biohazard containment of samples returned to Earth from bodies that could support native life (e.g., Mars and possibly moons, Europa, Enceladus)
- On human missions, characterize and monitor human health status and microbial populations (flight system microbiome) over the mission time, to support recognition of alterations caused by exposure to planetary materials

Earth's Moon, Most Solar System Bodies

Documentation only; No Operational Constraints on *in situ* activities or sample return

Phobos/Deimos

Document *in situ* activities; Possible return constraints

Mars, Europa, Enceladus

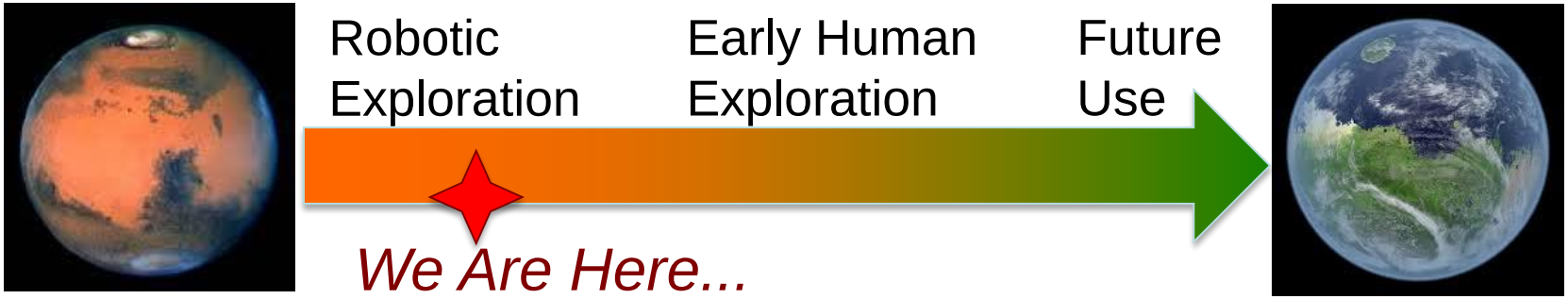
Documentation and operational restrictions to avoid introducing Earth life; Strict biohazard containment of returned samples

Planetary Protection for Humans on Mars

Planetary Protection Policy:

Protect the Earth, Avoid Harmful Contamination

Adding humans, policy has the same intent–but different implementation

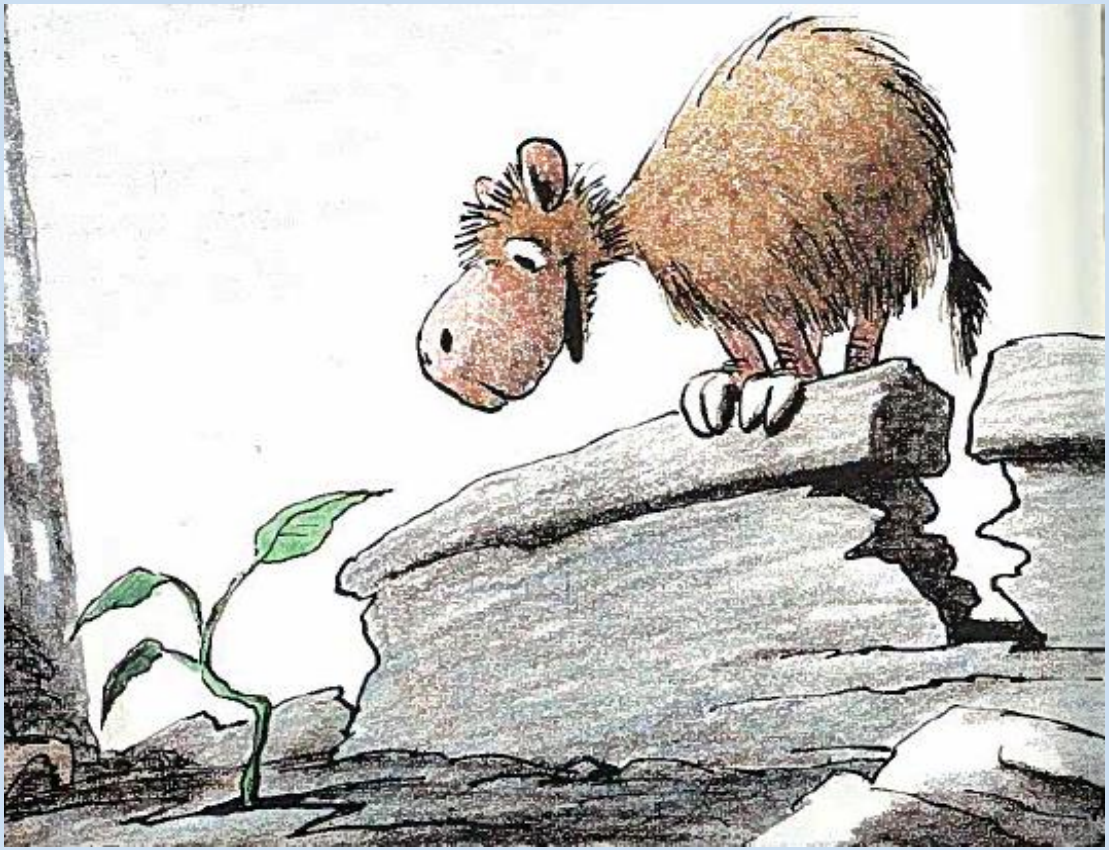


Phased Approach: Be careful early; tailor later constraints using knowledge gained

- Humans have many interests at Mars; understanding potential hazards supports all of them
- Searching for Mars life becomes more difficult, the more Earth contamination is introduced
- Future colonization could be challenged, if unwanted Earth invasive species are introduced
  - Blocking aquifers
  - Consuming resources
  - Interfering with planned introductions

Planetary Protection Makes Sense

If you're going somewhere to look for life...



W. Peet, 1974

Don't trash the place (or samples) before you have a chance to find it!

The Basic Rationale for Planetary Protection Precautions

(as written by Bart Simpson, Dec. 17, 2000, “Skinner’s Sense of Snow”)

Science class should not end in tragedy....
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